HYDROUS PYROLYSIS FOR OIL PRODUCTION IN SOURCE ROCKS: EFFECTS OF THERMAL MATURITY, LITHOLOGY AND EXPERIMENTAL CONDITIONS

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Introduction

Hydrous pyrolysis, a closed system procedure of heating a sample that is submerged in water, is the most promising laboratory configuration to replicate natural conditions to generate hydrocarbons from organic-rich rocks (Spigolon et. al., 2015). Experimental conditions can be adjusted in order to capture all stages of hydrocarbon formation and production of oil in situ. Several studies showed that it is possible to quantify changes in maturity by vitrinite reflectance measurements and hydrocarbon as well as biomarker composition (Liang et al., 2015). Changes of oils and bitumen by secondary cracking and the contribution of mineral components can be investigated as well (Miryuza, 2015). However, all the processes depend on rock characteristics, organic matter thermal maturity and even petrophysical properties.

Jurassic sediments of West Siberia, Russia, are known as formation that contain highest amount of shale oil in the world. Type II kerogen is the main source of oil in the sediments, its content might be up to 30%. Thermal maturity is very low on the south and might achieve end of the oil window on the north of West Siberia. Meanwhile there are only few areas where production of shale oil is successful. New technologies are necessary to increase oil yield from organic-rich rocks on the depth over 2500 km. Hydrous pyrolysis may offer opportunities for oil generation in situ. This study is performed to investigate effect of different rock parameters and experimental conditions on kerogen cracking in Jurassic organic-rich rocks.

Results

For hydrous pyrolysis organic-rich rocks with thermal maturity range between 0.5 to 1.15% vitrinite reflectance, different mineral composition and structure were chosen. Experimental temperature varied from 250°C and 470°C, reservoir pressure achieved by water pressure in autoclave, and experimental duration range between 5 hours and 2 months. After cooling the autoclave oil was extracted with hexane, separated from solvent and weighted. Oil characteristics were measured by GC-MS and GC-HRT chromatography. Rock-eval measurements were performed on the rocks before and after extraction.

The maximum yield of liquid hydrocarbons depends on complex of parameters and may achieve 15% of TOC. The more mature the rocks are the higher temperature is necessary for oil generation. For immature rocks the maximum yield was obtained in the temperature range of 300-350°C, while temperature of 400°C is necessary for maximum oil production from rocks at the end of oil window. High content of silica and clay minerals increases the yield while carbonates and abundance of organic matter have negative effect on oil generation process.

Duration of the experiment and high temperatures not only increase, but then decrease the amount of produced oil due to secondary cracking. Kinetic of the secondary cracking was observed by different chromatography methods showing decrease of high molecular weight compounds and increase of light ones. GC-MS investigations confirm conclusions on negative
effect of carbonates and high organic matter content on the process of oil formation. While in clay-silica rocks with 5-15% TOC hydrocarbons distribution change in oil has the pattern in accordance with experimental conditions and kerogen maturity, composition of oil from kerogen-carbonate-silica rocks vary dramatically without exact behavior with main parameters. Further investigations including additional methods should be performed with such rocks.

Comparison of oil compositions generated by hydrous pyrolysis from organic-rich rocks with different maturity and lithological characteristics provides idea of oil fabric in situ. Different fraction of aliphatic and aromatic compounds (Fig. 1), ratio of short-chain and long-chain alkanes and presence or absence of other compounds might be produced by varying temperature and duration of hydrous pyrolysis for rocks with identified properties.

![Figure 1 Composition of oils generated by hydrous pyrolysis in organic-rich rocks (350-300-2 - 350°C, 300 atm, 2 days)](image)

**Conclusions**

Knowing rock composition and organic matter maturity and varying experimental conditions both yield and composition of oil might be selected. Hydrous pyrolysis is the perspective method for oil generation in immature organic-rich rocks, but might be used also for increasing oil production from wells where both amount of adsorbed hydrocarbons and kerogen generation potential are high.

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**References**